

APPENDIX B

STANDARD OPERATING PROCEDURES

**MWHA INDUSTRIAL GROUP AND FEDERAL GROUP
STANDARD OPERATING PROCEDURES**

**SOP-9
SURFACE WATER AND SEDIMENT SAMPLING**

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1.0 INTRODUCTION

This Standard Operating Procedure describes methods and equipment commonly used for collecting environmental samples of surface water and aquatic sediment for either on-site examination or chemical testing, or for laboratory analysis.

The information presented in this guideline is generally applicable to all environmental sampling of surface waters and aquatic sediments, except where the analyte(s) may interact with the sampling equipment. The collection of concentrated sludges or hazardous waste samples from disposal or process lagoons often requires methods, precautions, and equipment different from those described herein.

Specific sampling problems may require the adaptation of existing equipment or design of new equipment. Such innovations should be described in the sampling plan (or addendum to the sampling plan if the remedial investigation is ongoing) and brought to the attention of the project manager.

2.0 DEFINITIONS

Environmental Sample	Low constituent-concentration sample typically collected off site and not requiring Department of Transportation (DOT) hazardous waste labeling or Contract Laboratory Program (CLP) handling as a high hazard sample.
Hazardous Waste Sample	Medium to high constituent-concentration sample (e.g., source material, sludge, leachate) requiring DOT labeling and CLP handling as a high hazard sample.

3.0 RESPONSIBILITIES

The **Field Team Leader** has overall responsibility for the correct implementation of surface water and sediment sampling activities, including review of the sampling plan with, and any necessary training of, the sampling technician(s). The actual collection, packaging, documentation (sample label and log sheet, chain-of-custody record, etc.) and initial custody of samples will be the responsibility of the sampling technician(s).

4.0 PROCEDURES

4.1 BACKGROUND

Collecting a representative sample from surface water or sediments is often difficult because of water movement, stratification, or the intermittent nature of these media. To collect representative samples, sampling bias must be standardized relative to site selection; sampling frequency; sample collection; sampling devices; and sample handling, preservation, and identification.

Representativeness is a qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important quality not only for assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and sample collection methods are important to ensure that a truly representative sample has been taken. Regardless of scrutiny and quality control applied during laboratory analyses, reported data are no better than the confidence that can be placed in the representativeness of the samples.

4.2 DEFINING THE SAMPLING PROGRAM

Factors that must be considered in developing a sampling program for surface water or sediments, including study objectives, are accessibility; site topography; flow, mixing, and other physical characteristics of the water body; point and diffuse sources of contamination; and personnel and equipment available to conduct the study. For waterborne constituents, dispersion depends on the vertical and lateral mixing within the body of water. For sediments, dispersion depends on bottom current or flow characteristics, sediment characteristics (density, size) and geochemical properties (which affect adsorption/desorption). The professional developing the sampling plan must therefore know not only the mixing characteristics of streams and lakes, but also must understand the role of fluvial-sediment transport, deposition, and chemical sorption.

4.2.1 Sampling Program Objectives

The objective of surface water sampling is to determine the surface water quality entering, leaving, or remaining within the site. The scope of the sampling program must consider the sources and potential pathways for transport of contamination to or in a surface water body. Sources may include point sources (leaky tanks, outfalls, etc.) or nonpoint sources (e.g., spills). The following are major pathways for surface water contamination (not including airborne deposition):

- Overland runoff
- Leachate influx to the water body
- Direct waste disposal (solid or liquid) into the water body
- Groundwater influx

The relative importance of these pathways, and therefore the design of the sampling program, is controlled by the physiographic and hydrologic features of the site, the drainage basin(s) that encompass the site, and the history of site activities.

Physiographic and hydrologic features to be considered include the following:

- Slopes and runoff direction
- Areas of temporary flooding or pooling
- Tidal effects
- Artificial surface-runoff controls such as berms or drainage ditches (and when they were constructed relative to site operation)
- Locations of springs, seeps, marshes, etc.

In addition, the obvious considerations such as the location of man-made discharge points to the nearest stream (intermittent or flowing), pond, lake, estuary, etc., should not be overlooked.

A more subtle consideration in designing the sampling program is the potential for dispersion of dissolved or sediment-associated contaminants away from the source. The dispersion could lead to a more homogeneous distribution of contamination at low or possibly non-detectable

concentrations. Such dispersion, however, does not always readily occur. For example, obtaining a representative sample of contamination from a main stream immediately below an outfall or a tributary is difficult because the inflow frequently follows a stream bank with little lateral mixing for some distance. Sampling alternatives to overcome this situation are to 1) move the sampling site far enough downstream to allow for adequate mixing, or 2) collect integrated samples in a cross section. Also, nonhomogeneous distribution is a particular problem with regard to sediment-associated contaminants, which may accumulate in low-energy environments (coves, river bends, deep spots, or even behind boulders) near or distant from the source, while higher energy areas (main stream channels) near the source may show no contaminant accumulation.

The distribution of particulates within a sample is an important consideration. Many organic compounds are only slightly water-soluble and tend to be adsorbed by particulate matter. Nitrogen, phosphorus, and heavy metals may also be transported by particulates. Samples must be collected with a representative amount of suspended material; transfer from the sampling device should include transferring a proportionate amount of the suspended material.

The first steps in selecting sampling locations, therefore, are to 1) review site history, 2) define the hydrologic boundaries and features of the site, and 3) identify the sources, pathways and potential distribution of contamination. Based on these considerations, the numbers, types, and general locations of required samples upgradient (for background measurement) on site and downgradient can be identified.

4.2.2 Location of Sampling Stations

Accessibility is the primary factor affecting sampling costs. The desirability and utility of a sample for analysis and description of site conditions must be balanced against the costs of collection as controlled by accessibility. Bridges or piers are the first choice for locating a sampling station on a stream because bridges provide ready access and permit the sampling technician to sample any point across the stream. A boat or pontoon (with an associated increase in cost) may be needed to sample locations on lakes and reservoirs, as well as those locations on larger rivers. Frequently, however, a boat will take longer to cross a water body and will hinder

manipulation of the sampling equipment. Wading for samples is not recommended unless it is known that contaminant levels are low enough that skin contact will not produce adverse health effects. This provides a built-in margin of safety in the event that wading boots or other protective equipment should fail to function properly. If it is necessary to wade into the water body to obtain a sample, the sampler should be careful to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If necessary, the sampling technician should wait for the sediments to settle before taking a sample.

Sampling in marshes or tidal areas may require the use of an all-terrain-vehicle. The same precautions mentioned above with regard to sediment disturbance will apply.

Under ideal and uniform contaminant dispersion conditions in a flowing stream, the same concentrations of each would occur at all points along the cross section. This situation is most likely downstream of areas of high turbulence. Careful site selection is needed to ensure, as closely as possible, that samples are taken where uniform flow or deposition and good mixing conditions exist.

The availability of streamflow and sediment discharge records can be an important consideration in choosing sampling sites in streams. Streamflow data in association with contaminant concentration data are essential for estimating the total contaminant loads carried by the stream. If a gauging station is not conveniently located on a selected stream, the project hydrologist should explore the possibility of obtaining streamflow data by direct or indirect methods.

4.2.3 Frequency of Sampling

The sampling frequency and the objectives of the sampling event will be defined by the work plan. For single-event site- or area-characterization sampling, both bottom material and overlying water samples should be collected at the specified sampling stations. If valid data are available on the distribution of the contaminant between the solid and aqueous phases, it may be appropriate to sample only one phase, although this is not often recommended. If samples are collected primarily for monitoring purposes, consisting of repetitive, continuing measurements to define variations and trends at a given location, water samples should be collected at a pre-

established and constant interval as specified in the work plan (often monthly or quarterly) and during droughts and floods. Samples of bottom material should be collected from fresh deposits at least yearly, and preferably during both spring and fall seasons.

The variability in available water-quality data should be evaluated before deciding on the number and collection frequency of samples required to maintain an effective monitoring program.

4.3 SURFACE WATER SAMPLE COLLECTION

4.3.1 Streams, Rivers, Outfalls, and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls, and drainage features at a single point vary from the simplest of hand-sampling procedures to the more sophisticated multipoint sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (defined below).

Samples from different depths or cross-sectional locations in the water course taken during the same sampling episode should be composited. However, samples collected along the length of the watercourse or collected at different times may reflect differing inputs or dilutions and therefore should not be composited. Generally, the number and type of samples to be taken depend upon the width of the river, depth, discharge, and the suspended sediment the river transports. The greater number of individual points that are sampled, the more likely that the composite sample truly will represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross section.

For larger streams, at least one vertical composite should be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. Measurements of dissolved oxygen (DO), pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical

composite and on the composite itself. For rivers, several vertical composites should be collected.

4.3.2 Lakes, Ponds, and Reservoirs

Lakes, ponds, and reservoirs have a much greater tendency to stratify than rivers and streams do. The relative lack of mixing requires that a high number of samples be obtained to adequately represent the overall characteristics of the water body.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, measurements of DO, pH, temperature, etc., are to be conducted on each aliquot of the vertical composite. In naturally formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites should be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the upper, warmer, and less dense layer of lake water (above the thermocline) that is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer that is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones thus may have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur between these areas. Similarly, additional samples should be taken where discharges, tributaries, land-use characteristics, and other such factors are suspected of influencing water quality.

Most lake measurements should be made in-situ using sensors and automatic readout or recording devices. Single and multiparameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential, specific conductance, dissolved oxygen, some cations and anions, and light penetration.

4.3.3 Estuaries

Estuarine areas are by definition zones where inland fresh waters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types, depending on freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations. Following are the three types of estuaries:

- Mixed estuary—characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Since they are well mixed, the sampling locations are not critical in this type of estuary.
- Salt wedge estuary—characterized by a sharp increase in salinity with depth and stratified freshwater flow along the surface. In these estuaries, the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.
- Oceanic estuary—characterized by salinity approaching full-strength oceanic waters. Seasonally, freshwater inflow is small, with the preponderance of the fresh-saline water mixing occurring near, or at, the shoreline.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e., when the tide turns). Estuarine sampling programs should include vertical salinity measurements at 1- to 5-foot increments coupled with vertical DO and temperature profiles.

4.3.4 Sampling Equipment and Techniques

The selection of sampling equipment depends on the site conditions and sample type required. In addition, the chemical compatibility of the sampling equipment with the constituents of

concern must be addressed prior to initiating the sampling program. The following are the most frequently used samplers:

- Open-mouth bottle sampler (dip sampler)
- Weighted bottle sampler
- Hand pump
- Thief samplers
- Depth-Integrating sampler

The open-mouth bottle sampler (dip sampler) and the weighted bottle sampler are used most often.

The criteria for selecting a sampler include the following:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation, particularly if personnel protection required is above Level D
- Nonreactive/noncontaminating—Teflon[®]-coated, glass, stainless steel, or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) should be measured for the following:

- Specific conductance
- Temperature
- pH (optional)
- DO (optional)

These items should be measured for as soon as the sample is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

Open-Mouth Bottle Sampling (Dip Sampling)

Water is often sampled by filling a container, either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample [Figure 1]). Constituents measured in

grab samples are only indicative of conditions near the surface of the water and may not truly represent the total concentration distributed throughout the water column and in the cross section. Therefore, dip samples should be augmented whenever possible with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

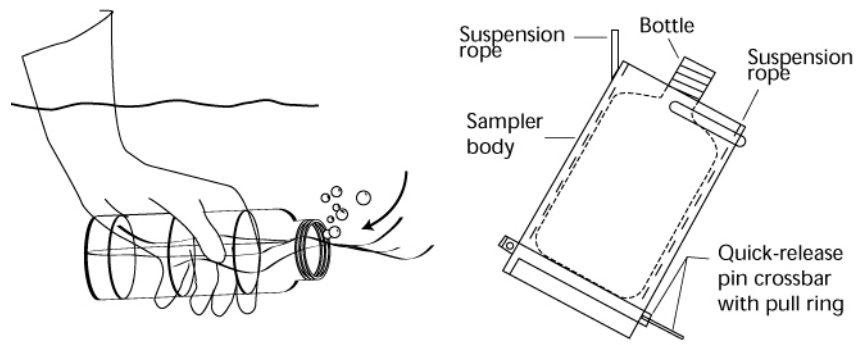
Sample bottles containing preservatives should never be used to directly collect surface water samples.

Weighted Bottle Sampling

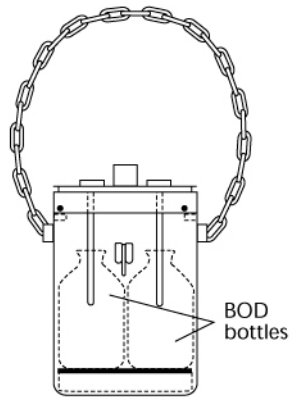
A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and then raised to the surface at a uniform rate. In this manner the sample will be collected throughout the depth interval and will be filled just before it reaches the surface. Using either method, the resulting sample will roughly approach what is known as a depth-integrated sample.

A closed, weighted bottle sampler consists of a stoppered glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle (Figure 1). The procedure for sampling is:

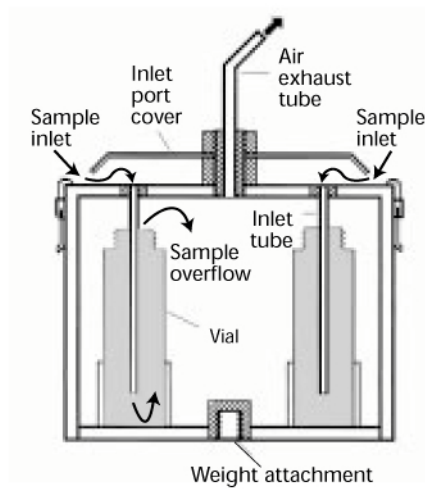
1. Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).
2. Pull out the stopper with a sharp jerk of the sampler line.
3. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.
4. Raise the sampler and cap the bottle
5. Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).



A. Hand-held open-mouth bottle sampler **B.** US WBH-96 weighted bottle sampler



C. BOD sampler



D. VOC sampler

Not to scale

Figure 1 Examples of Open Mouth Samplers

(Source: USGS, 1997-1999)

Hand Pumps

Hand pumps may operate by peristaltic, bellows, diaphragm, or siphon action. Hand pumps that operate by bellow, diaphragm, or siphon action should not be used to collect samples that will be analyzed for volatile organics because the slight vacuum applied may cause loss of these contaminants. To avoid contamination of the pump, a liquid trap consisting of a vacuum flask or other vessel to collect the sample should be inserted between the sample inlet hose and the pump.

Tubing used for the inlet hose should be nonreactive (preferably Teflon[®]). The tubing and liquid trap must be thoroughly decontaminated between uses (or disposed of after one use).

When sampling, the tubing is weighted and lowered to the desired depth. The sample is then obtained by operation of the pump, and subsequently transferred from the trap to the sample container.

Thief Samplers

Thief samplers are used to collect “point” samples from a specific depth. Examples of thief samplers include Kemmerer and Van Dorn samplers, and double check-valve bailers (Figure 2). The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In both the Kemmerer and Van Dorn samplers, a "messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. A double check-valve bailer is similar to a Kemmerer sampler in that it allows free passage of water through the cylinder until the desired sampling depth is reached. However, the check valves automatically close when the bailer is retrieved. Water is removed through a valve to fill sample bottles.

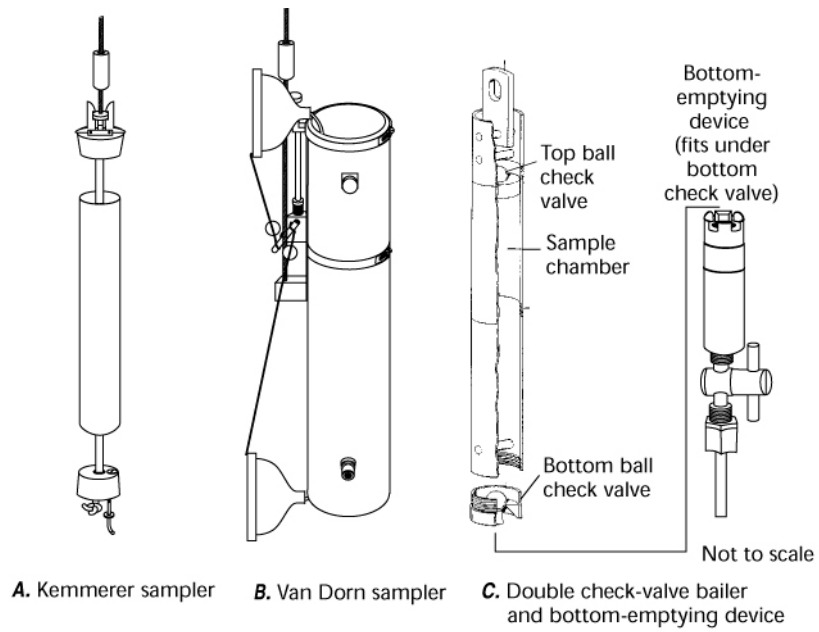


Figure 2 Examples of Thief Samplers

(Source: USGS, 1997-1999)

Depth-Integrated Sampling

Depth integration is used to collect a water and suspended material sample, in direct proportion to relative velocity at each increment of depth. This means that the volume of water and suspended material must enter the sample bottle at a rate proportional to the velocity of the flow passing the intake of the sampler. If a depth-integrating sampler is lowered from the surface to the bed and back at the same rate, and presuming that the sampler is not overfilled during the course of the sampling operation, each increment of flow in that vertical is sampled proportionately to the velocity. The minimum stream velocity must be greater than 1.5 feet per second (ft/s) for a depth-integrated sampler with a rigid bottle, or greater than 3.0 ft/s for a depth-integrated sampler with a bag (USGS, 1998).

One method of collecting depth-integrated samples is the EWI technique. Samples are taken at several equally spaced verticals across the stream, with the transit rate of the sampler (that is, the velocity at which the sampler is passed through the water column) the same in all verticals. The samples collected in each vertical are then composited into a single sample representative of the entire flow in the cross section. Because the volume collected in each vertical sample will be directly in proportion to depth and velocity at the vertical location, the composite sample of the water-sediment mixture flowing in the cross section will be discharge-weighted.

In the EDI technique, the positions of sampling verticals across the stream are based on incremental discharges rather than width (i.e., deeper or higher velocity areas of the stream cross section are sampled at a closer spacing). This method provides the most accurate measure of total discharge of the contaminant for streams that are not well mixed; however, it requires knowledge of the cross-sectional stream flow distribution.

The EDI method has these advantages: variable transit rates may be used because samples can be composited in proportion to known stream flow distribution, fewer verticals need to be sampled, and cross-section discharge information is obtained. The primary disadvantage of the method is that the streamflow distribution in the cross section must be known or measured each time before sampling.

The EWI method has these advantages: discharge measurements are not needed, the technique is learned easily, and the technique is applicable where cross-sectional stream flow distribution varies because of shifting beds or other causes. The main disadvantages are that the procedure is time consuming for large streams and does not provide quantitative information on cross-sectional discharge because this parameter does not need to be measured for the EWI method. Furthermore, the EWI method requires sampling at equally spaced verticals and use of identical transit rates within each vertical.

Because these multi-point sampling techniques can become very time consuming and expensive, an alternate method often used involves sampling at the quarter points or other equal intervals across the width of the stream. Composites of individual samples collected at the quarter points can be fairly representative, providing the stream cross section is properly located.

Several depth-integrating samplers specifically designed and suitable for collecting representative samples are available and include the US DH-81, US DH-95, US DH-77 samplers (Figure 3). US DH-81 or US DH-95 samplers can be used where flowing water can be waded or where a bridge is accessible. The US DH-77 (or the D-77 Bag, or Frame-Bag sampler) is a cable-and-reel sampler for use when flowing water cannot be waded.

Because of the number and diversity of analyses that may be performed on collected surface water or water-sediment mixtures, a sample splitter will often be required. A churn splitter is a practical means for splitting composited samples into representative subsamples.

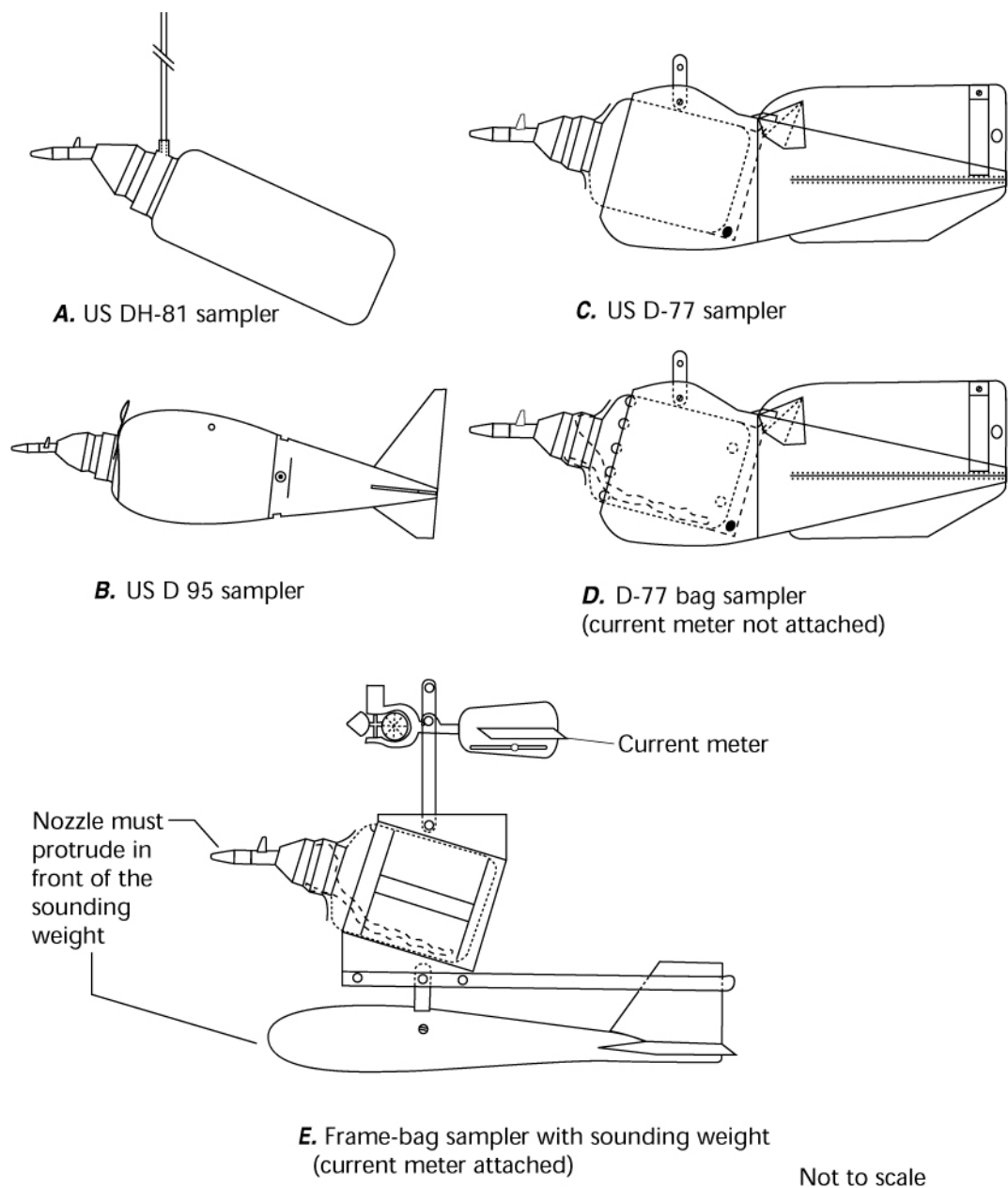


Figure 3 Depth-Integrating Samplers

(Source: USGS, 1997-1999)

4.4 SEDIMENT SAMPLING

4.4.1 General

Sediment samples are usually collected at the same locations where surface water samples were collected. If only one sediment sample is to be collected, the site should be approximately at the center of the water body. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials that may contain greater concentrations of contaminants because of their lower porosity and greater surface area available for adsorption. The shape, flow pattern, bathymetry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends; behind islands or boulders; quiet, shallow areas; or very deep, low-velocity areas) should be sampled while areas likely to show net erosion (high velocity, turbulent areas) and suspension of fine solid materials should be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom-material samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained materials) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water-column concentrations are below detection limits). Therefore, it is important to minimize the loss of low-density "fines" during any sampling process.

4.4.2 Sampling Equipment and Techniques

A sediment sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using onshore or offshore techniques.

When boats are used for sampling, life preservers must be provided and two individuals must undertake the sampling. An additional person should remain on shore in visual contact at all

times. Please refer to the site-specific health and safety plan for details regarding sampling from a boat.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Core samplers
- Hand-operated gravity corers
- Dredge samplers

Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood, or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination because the scoop can be discarded or easily decontaminated between samples. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping the sample along the bottom in the upstream direction. The sediment is then transferred from the scoop to the appropriate sample container. Please note that it is very difficult not to disturb fine-grained materials of the sediment-water interface when using a scoop sampler.

Core Samplers

Core samplers are used to sample vertical columns of sediment. They are useful when a historical record of sediment deposition is desired because they preserve the sequential layering of the deposit. Coring devices are particularly useful for sediments because they disturb fine-grained materials of the sediment-water interface less than other sampling methods. Also, the sample is withdrawn intact, permitting the removal of only those layers of interest and glass or Teflon[®] core liners can be used in order to prevent possible sample contamination. In addition, samples are easily labeled and submitted to the lab for analysis in the tube in which they are

collected. The disadvantage of coring devices is that a relatively small surface area and sample size is obtained, necessitating repetitive sampling to obtain enough sample for some analyses.

Many types of coring devices have been developed to address varying water depths, the nature of the bottom material, and the length of the core to be collected. In shallow wadeable waters, the direct use of a glass or Teflon[®] core liner or tube is recommended. Teflon[®] is preferred to avoid glass breakage and possible sample loss. The use of the tube by itself eliminates the need to decontaminate core barrels, cutting heads, and retainers between samples.

Core sampler tubes or liners should be approximately 12 inches long when only recently deposited sediments (8 inches or less) are to be sampled. Soft or semiconsolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with large-diameter tubes. However, because coarse or unconsolidated sediments such as sand and gravel will tend to fall out of the tube, a smaller diameter is required. A tube about 2 inches in diameter is usually sufficient. The wall thickness of the tube should be about 1/3 inch for either Teflon[®] or glass. The end of the tube may be tapered by filing it down to facilitate entry of the liner into the substrate.

Hand-Operated Gravity Corers

Hand corers are generally constructed of an outer rigid metal tube into which a plastic, brass, or Teflon[®] core sleeve fits with minimal clearance. The cutting edge of the corer has a recessed lip on which the core sleeve rests and which accommodates a plastic core catcher. The core catcher is composed of intermeshing "fingers" that point upward into the core sleeve so that when the sampler is pressed into the sediment, the core is free to move past the catcher, but the core cannot fall through the catcher upon removal of the sampler from the sediment.

Use of hand corers or liners involves pushing the device into the substrate until only 4 inches or less is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the corer while it is pushed will facilitate greater penetration and will reduce sample compaction. After the corer is slowly extracted, the liner is removed and capped with a sheet of Teflon held in place by a plastic cap. If the top or bottom of the liner contains water or air, the water should be carefully decanted (to avoid removal of surface sediments) and the ends packed

with clean silica sand. The caps are then placed and secured with friction tape, which is in contact with only the plastic cap and the outside of the liner. The orientation of the core should be marked on the sleeve and maintained during transport to the laboratory.

Gravity corers are used to obtain sediment samples in water bodies deeper than 3 to 5 feet. These samplers can be used for collecting 1 to 2 foot cores of fine-grained sediments from depths of up to several hundred feet beneath the water surface.

The gravity core sampler operates in a manner similar to the hand-operated core. A plastic, brass, or Teflon[®] liner fits within a metal core housing fitted with a cutting edge. Core-catchers are used to retain the core within the liner. An opening exists above the liner to allow free flow of water through the corer as it moves vertically through the water and into the sediment. The sampler has a messenger-activated valve assembly that seals the opening above the liner following sediment penetration, which creates a partial vacuum to assist in sample retention during retrieval.

Samples are obtained by allowing the sampler, which is attached to sufficient length of stainless steel cable, to drop to the bottom. The weight of the sampler drives the core into the sediment to varying depths depending on the characteristics of the sediments. The messenger is then dropped and the sampler carefully retrieved. Upon retrieval, treatment is similar to that described above for hand corers.

Dredges

Dredges are generally used to sample sediments that cannot easily be obtained using coring devices (i.e., coarse-grained or semi-consolidated materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets either may close upon impact or be activated by use of a messenger. Some dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman, and Ponar.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge should be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge performs well in sediments that are unusually soft (organic sludge or light mud). It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends, thus reducing the “shock wave” and permitting direct access to the secured sample without opening the closed jaws. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or scoops. Like Peterson dredge, the Ponar dredge is easily operated by one person, and is one of the most effective samplers for general use on all types of substrates.

5.0 REFERENCES

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